

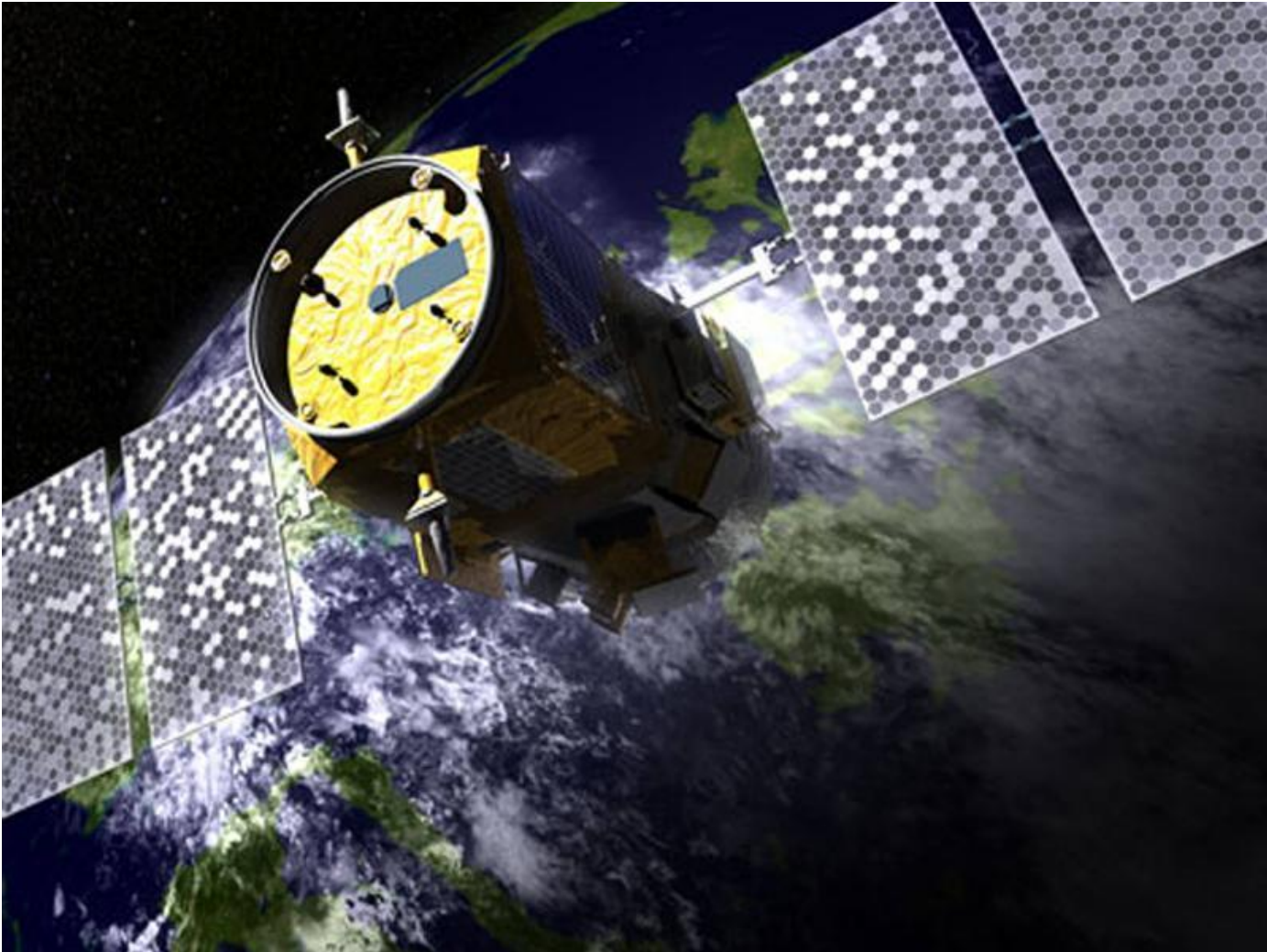
Montana Teen Driver Education and Training

Module 4.1

Natural Laws

Natural Laws Objectives

- Understand the physical laws and concepts that govern driving
- Understand and apply the concepts of Kinetic Energy
- Understand the relationship between friction and traction
- Calculate vehicle momentum and understand the relationship of vehicle mass, vehicle speed and their effects on vehicle crashes
- Use your skills to manage natural laws



Natural Laws

PHYSICS 101

Physics Concepts

- Gravity
- Kinetic Energy
- Momentum
- Force
- Inertia
- Friction
- Traction

Gravity

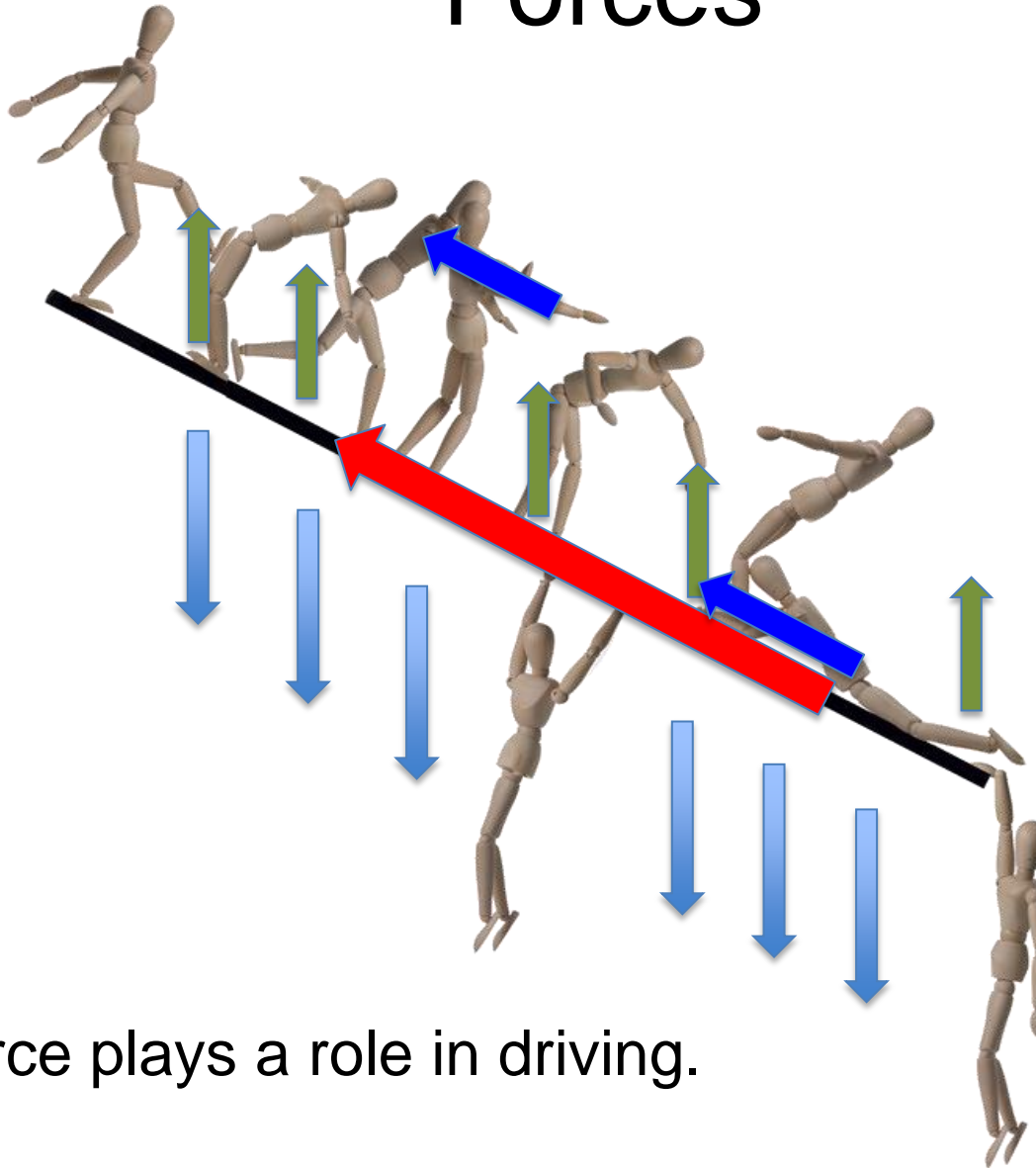
- The force that attracts a body toward the center of the earth
 - When I jump up I
 - When I throw a ball in the air it . . .
 - When I go off a cliff . . .

Gravity—It's not just a good idea. . .

It's the LAW!

(The Law of Physics)

Forces



Each force plays a role in driving.

Hills and Gravity



Kinetic Energy

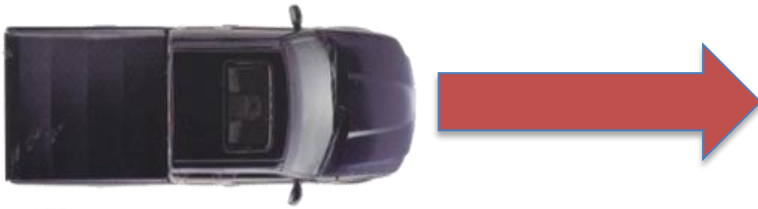
- Energy of Motion

$$KE = \frac{1}{2}mv^2$$

- KE is for Kinetic Energy
- M is for Mass
- V is for Velocity

Energy of Motion

20 MPH



40 MPH



Double the speed—quadruple the energy!

Stopping Distance



Stopping Distance



Momentum

- Mass in Motion
 - How much stuff and how fast the stuff is moving in one direction

$$\textit{Momentum} = \textit{mass} \times \textit{velocity}$$

Momentum



**Both the cyclist and SUV are traveling at the same speed—20 mph.
Which has the greater momentum?**

Energy in a Crash

Student Activity 1: Force of Impact

- Stand 1-2 inches from a wall with hands up facing wall and go as fast as possible into the wall protecting yourself with your hands. (Similar to sport coaches saying to run through the finish line.) Ask if there were any injuries.
- Step back one step and do the same, protecting self with the hands to prevent injury. Discuss whether or not injury could occur from this distance and why.
- Now step back five steps and ask what the results would be if you were to go through the finish line or wall from this distance. DO NOT actually run into the wall from this distance nor have a student attempt this.

Check out this road ...

- Describe what you see:
 - Roadway design
 - Road surface conditions
 - Space for error

As the driver, what decisions should you make?





QUESTION:

What would cause this 25-inch diameter high voltage power pole to break like this?



ANSWER:

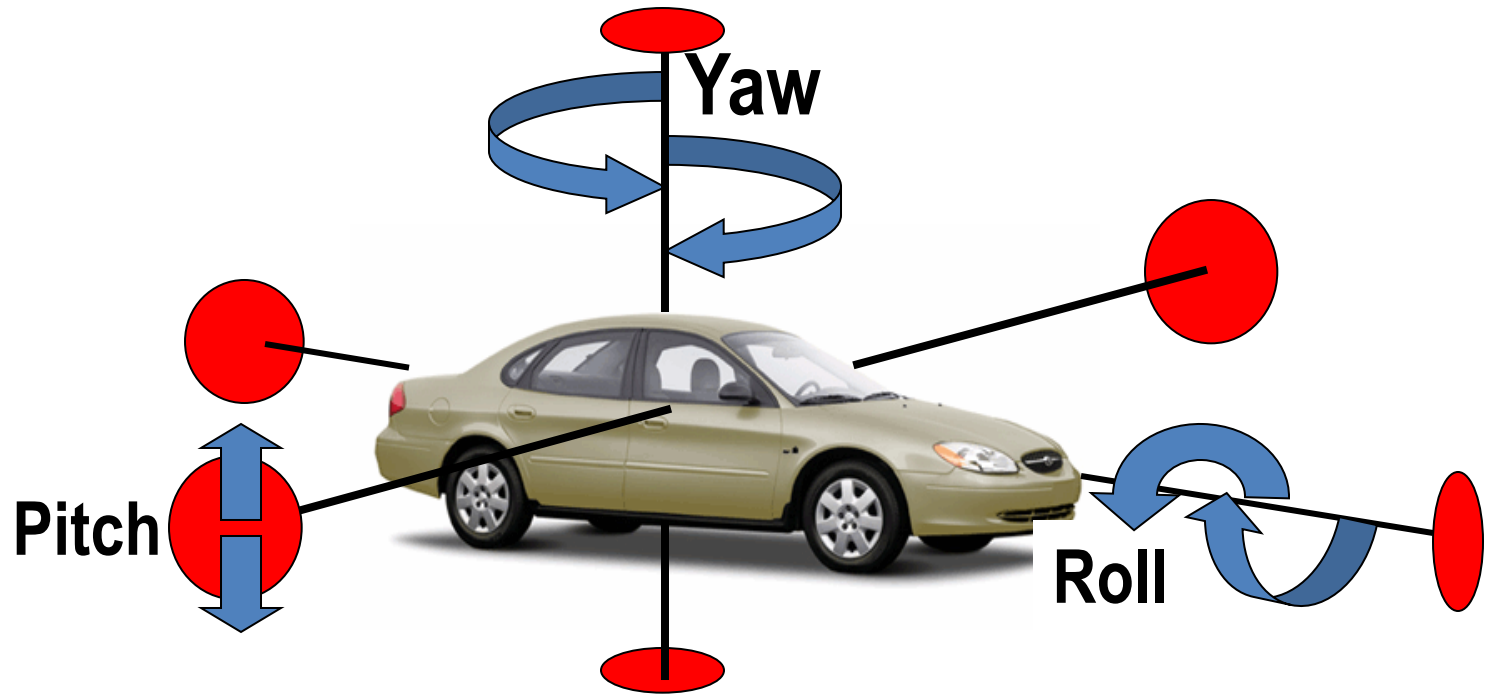
This Volvo traveling at 100mph when it lost control and struck the power pole!

That's why speed kills!



Remember Vehicle Balance

PITCH, ROLL, YAW?



Pitch



Student Activity 2: Pitch

- Stand up.
- Pretend that you are in a car moving at 35mph.
- The driver slams on the brakes.
- Demonstrate what your body does when the car suddenly stops.

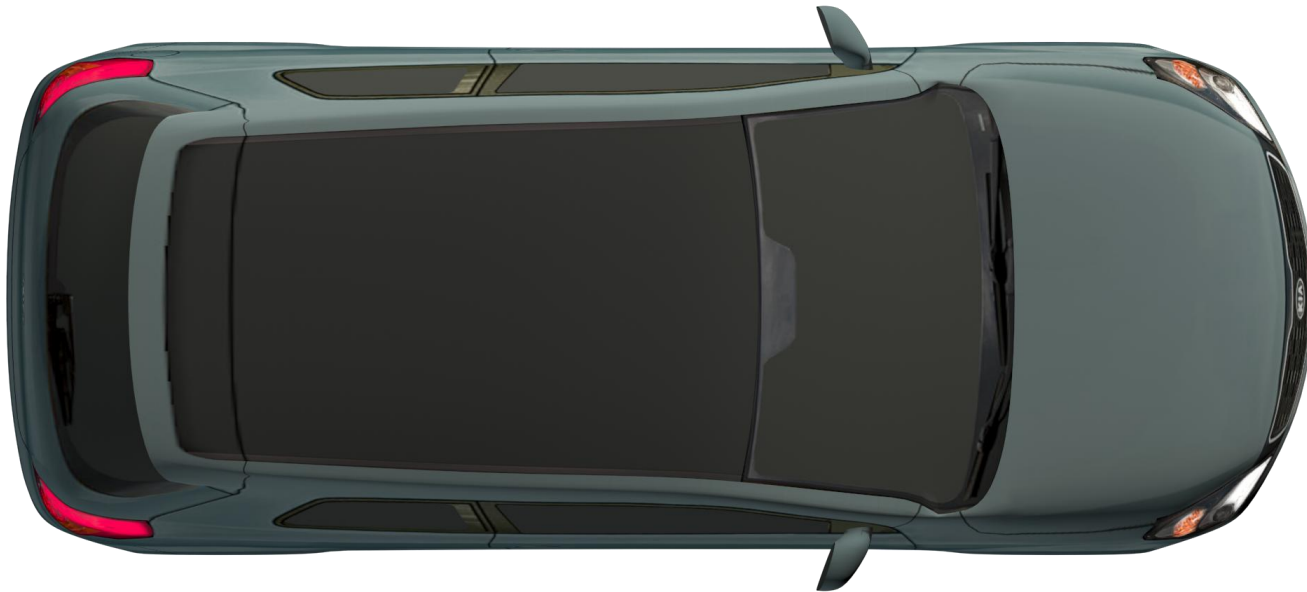
Roll



Student Activity 3: Roll

- Stand up.
- Pretend you are traveling in a car moving at 35mph.
- The driver turns sharply to the left.
- Demonstrate what your body does when the driver turns.

Yaw





Describe what is happening to this vehicle in balance terms.

FRICTION

Friction

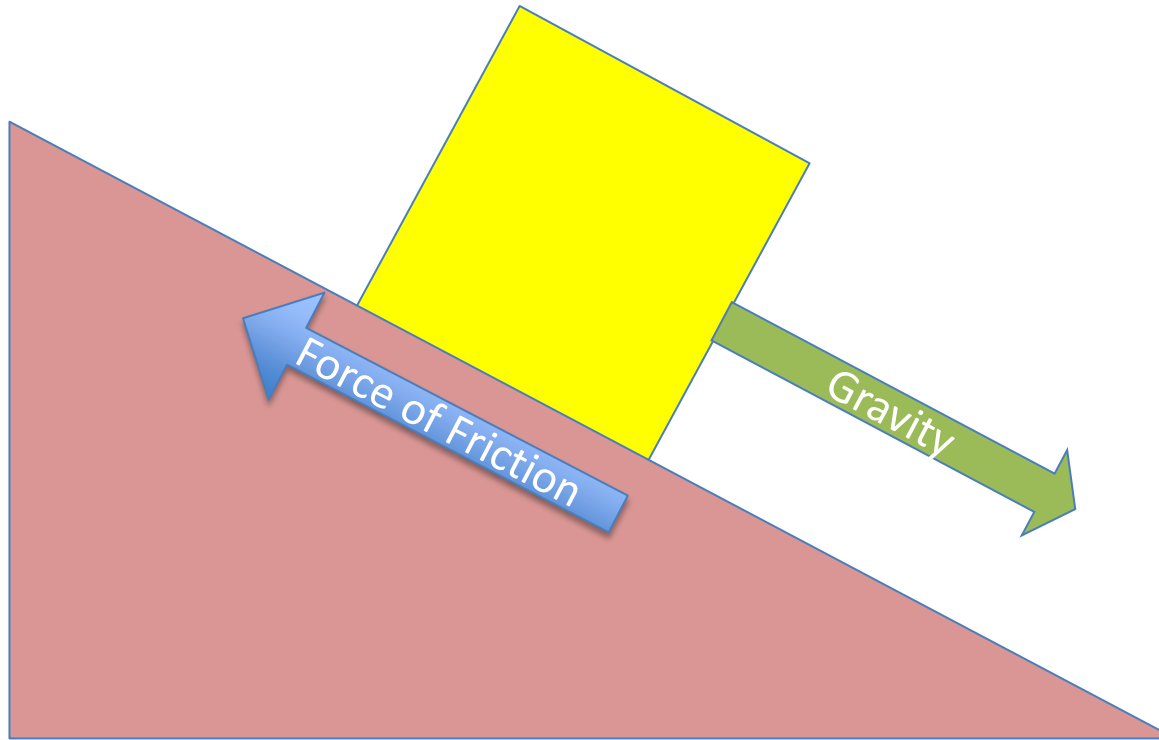
- The force when two surfaces move against each other and one surface resists the other.
- Described in terms of a coefficient of friction.
- Different surfaces have different coefficients of friction.

Student Activity 4: Friction

- Put your palms together and press them together firmly
- Rub them back and forth quickly for 30 seconds

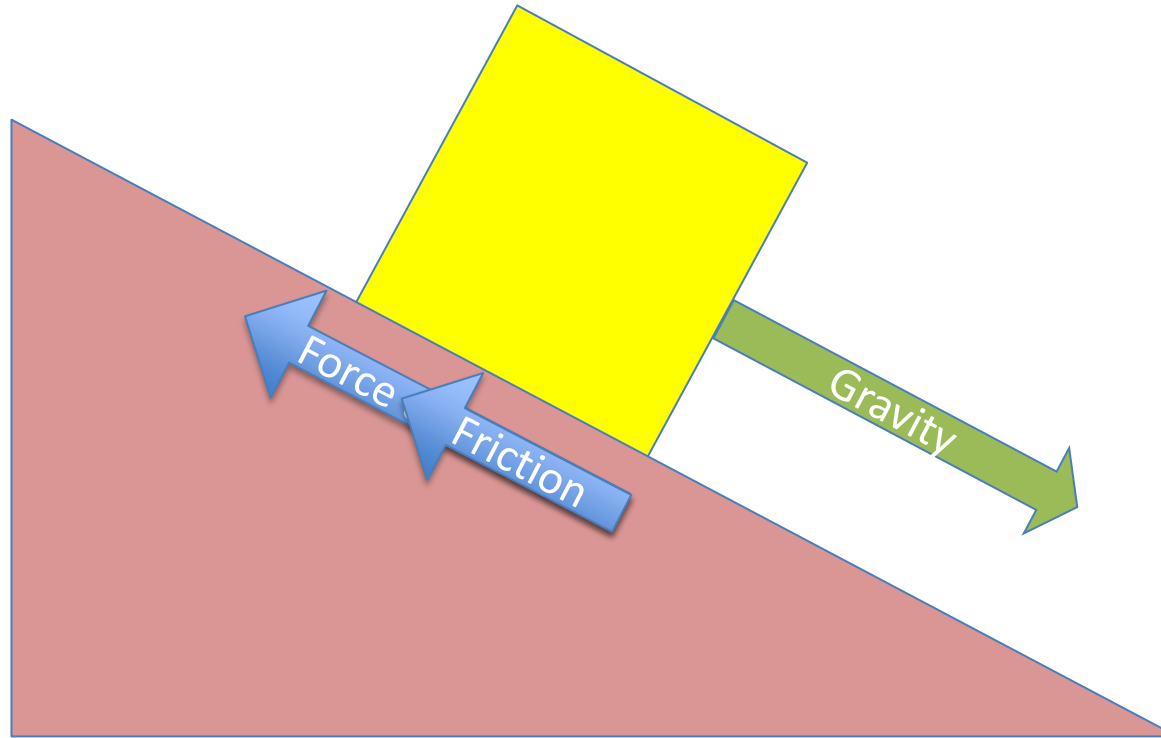
What happened as you rubbed your hands together?

Static Friction



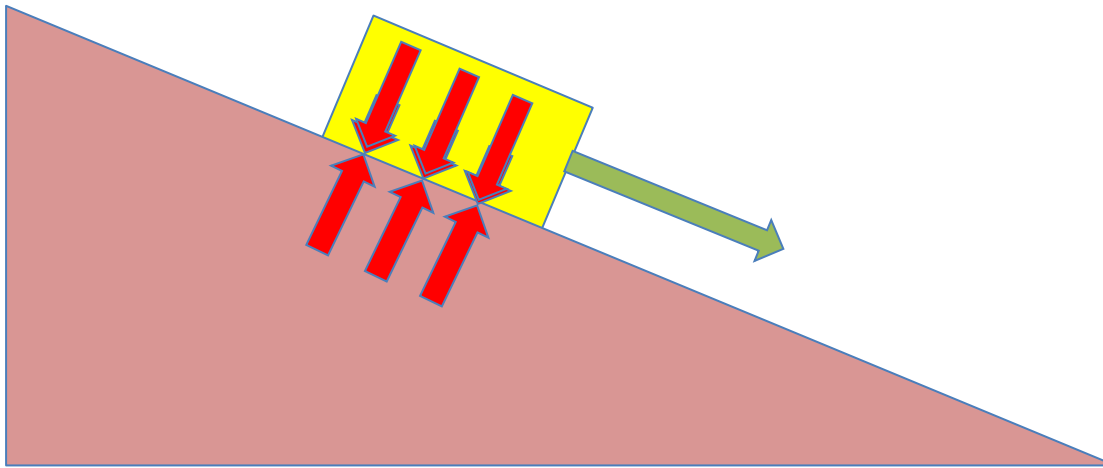
Force of Friction is equal to or greater than the force of gravity
Object doesn't move or remains static

Sliding Friction



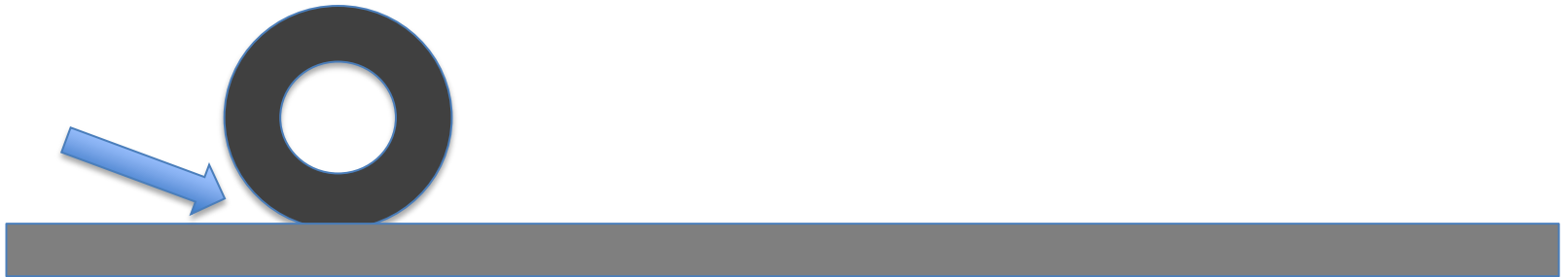
When the force of friction is less than the force of gravity
Object slides down the slope

Sliding Friction and Mass



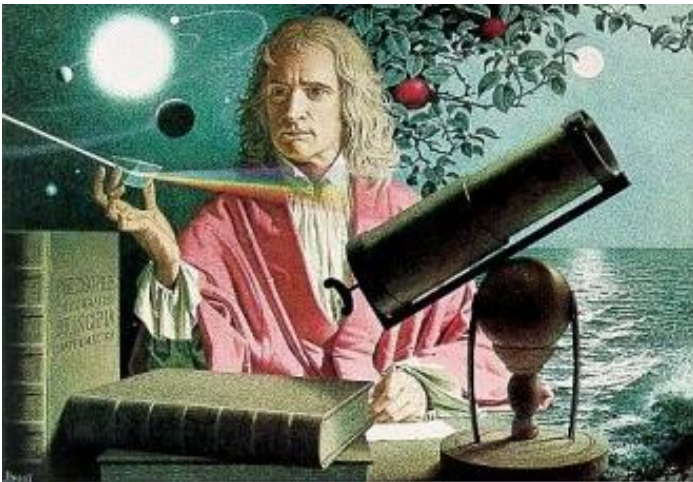
Rolling Friction

Friction between the ground and the tire



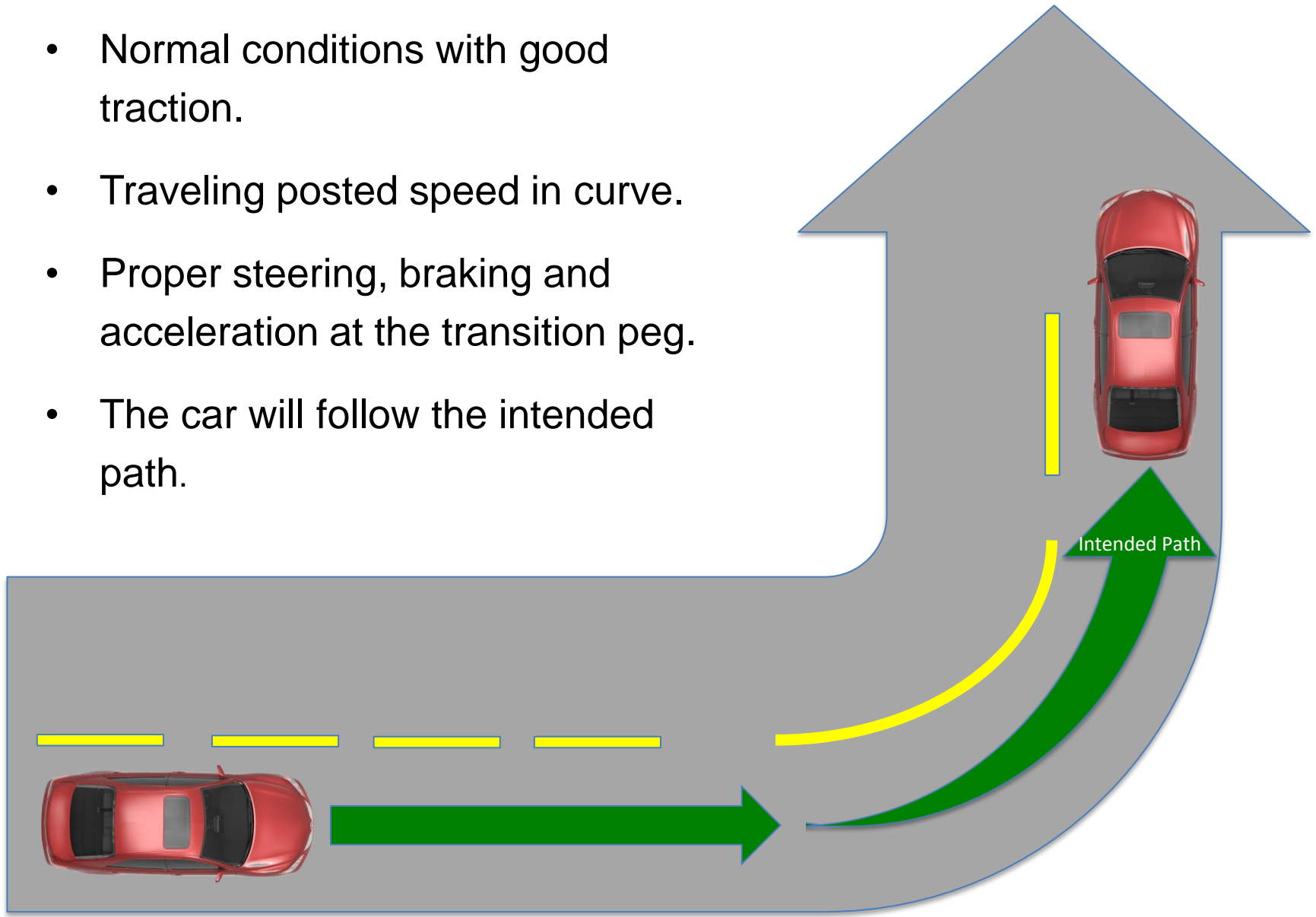
Inertia

- An object at rest.
- An object in motion. . . .

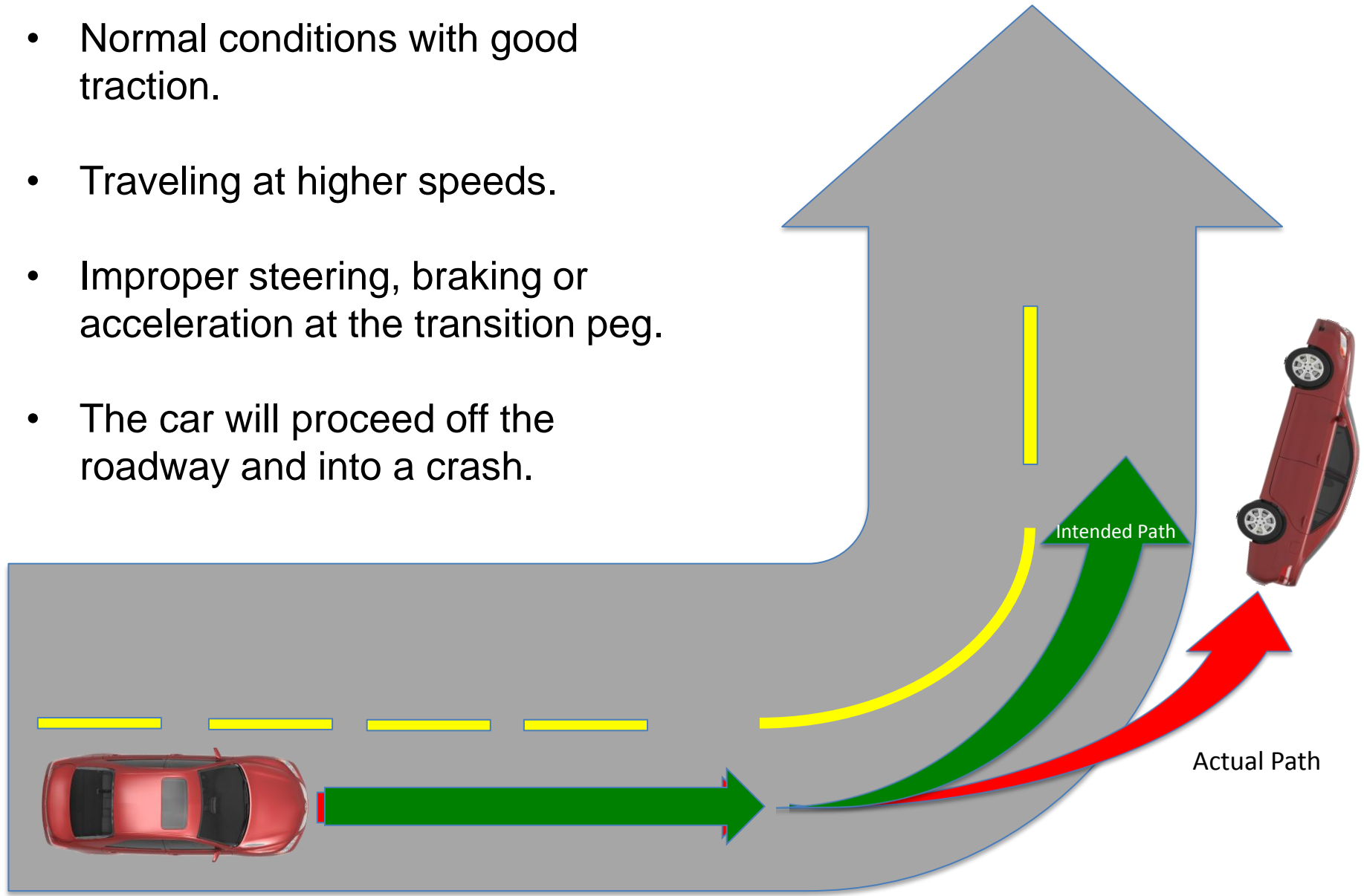


First published in 1666 by Sir Isaac Newton in
Principia Mathematica Philosophiae Naturalis.

- Normal conditions with good traction.
- Traveling posted speed in curve.
- Proper steering, braking and acceleration at the transition peg.
- The car will follow the intended path.



- Normal conditions with good traction.
- Traveling at higher speeds.
- Improper steering, braking or acceleration at the transition peg.
- The car will proceed off the roadway and into a crash.





What is traction?

The ability of the tires to grip the surface of the road.

What limits the amount of traction?

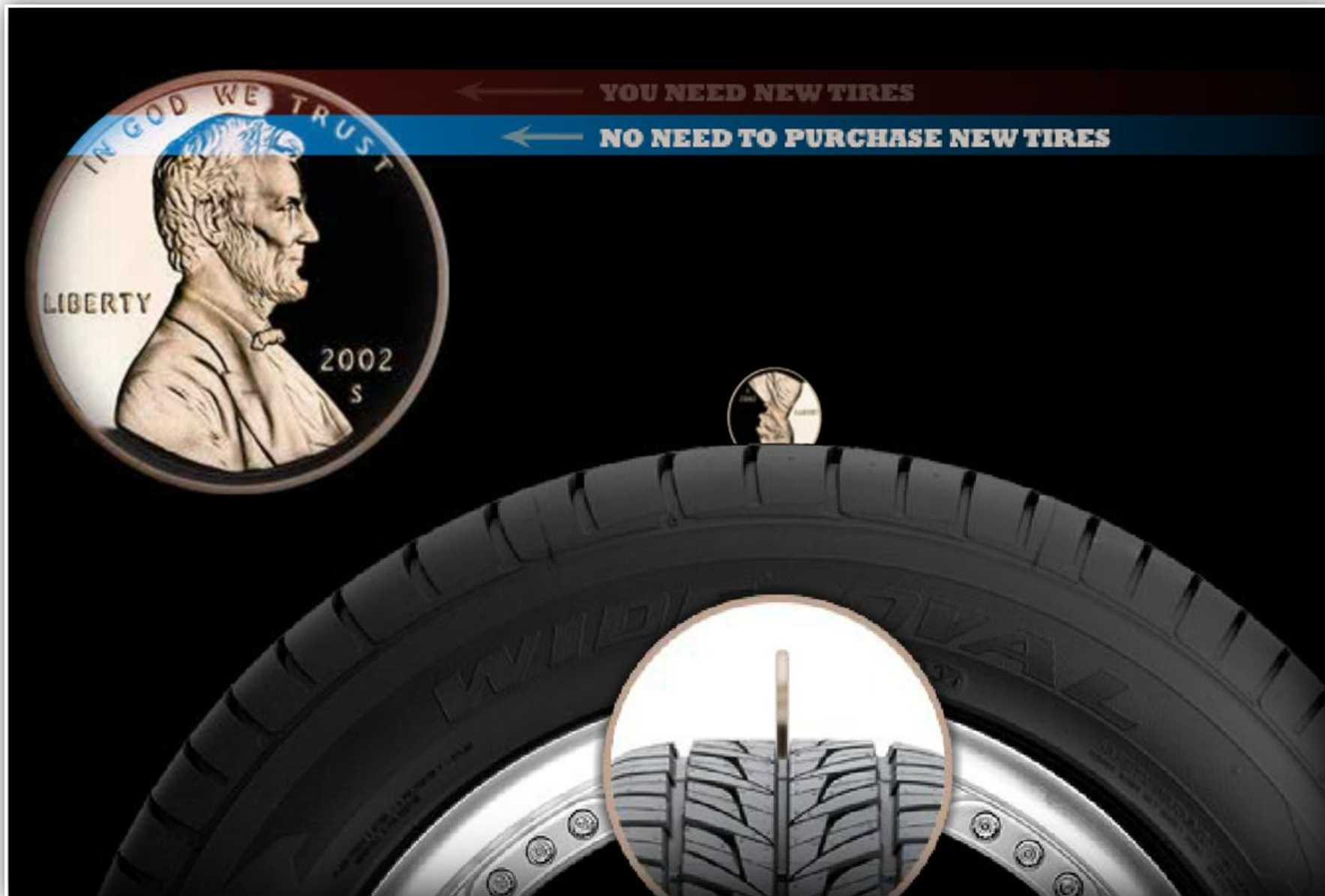
- Conditions of tires
- Conditions of the roadway
- Vehicle speed, pitch, and roll forces

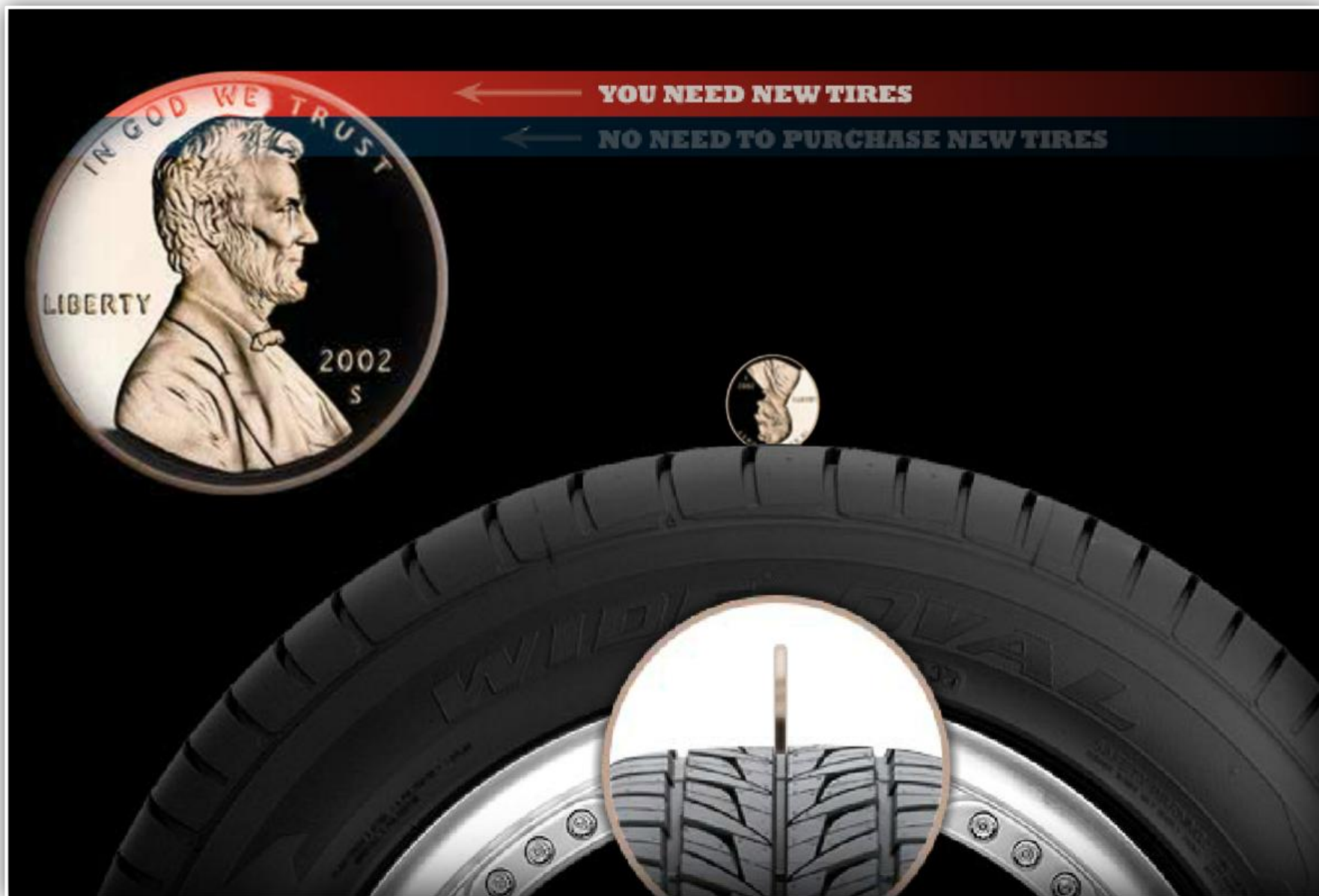


Which tire has better tread?

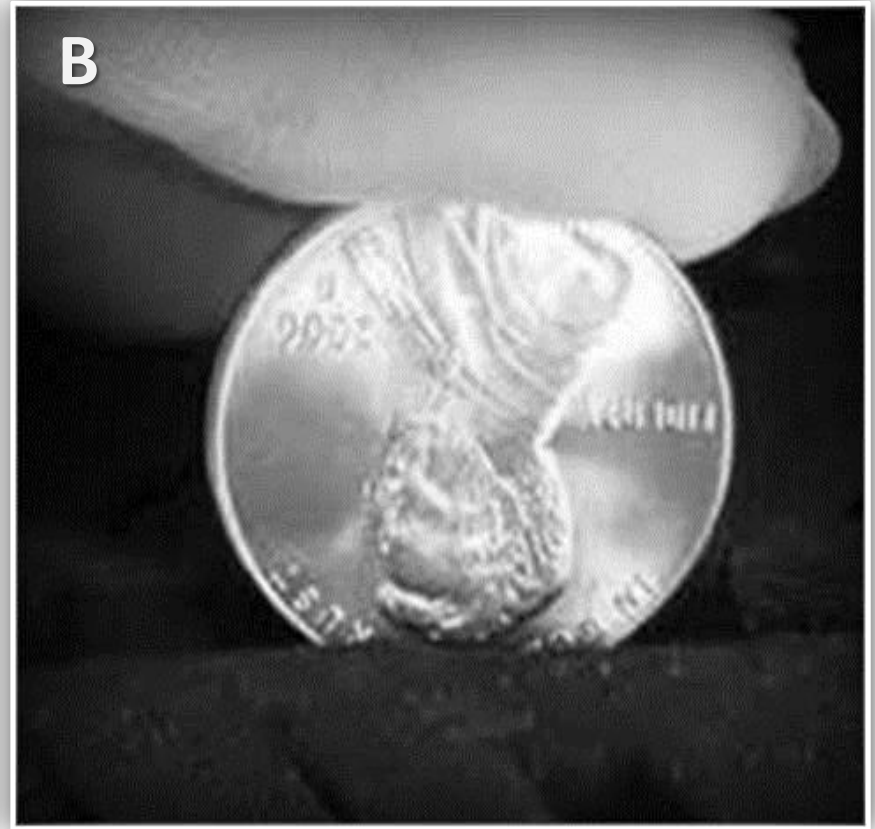
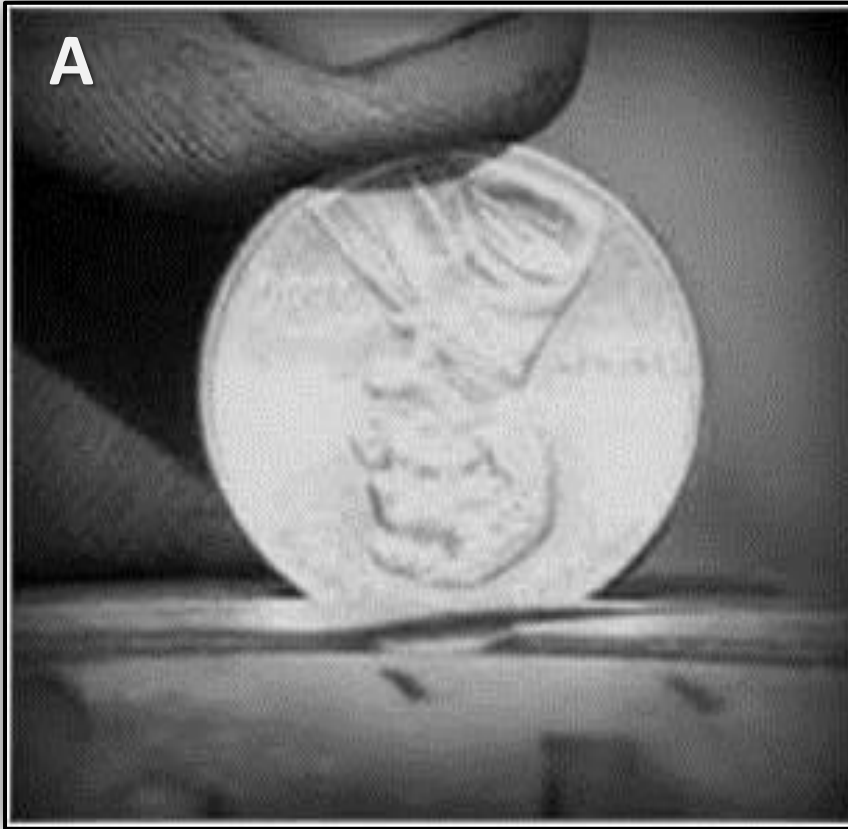
How can you tell?







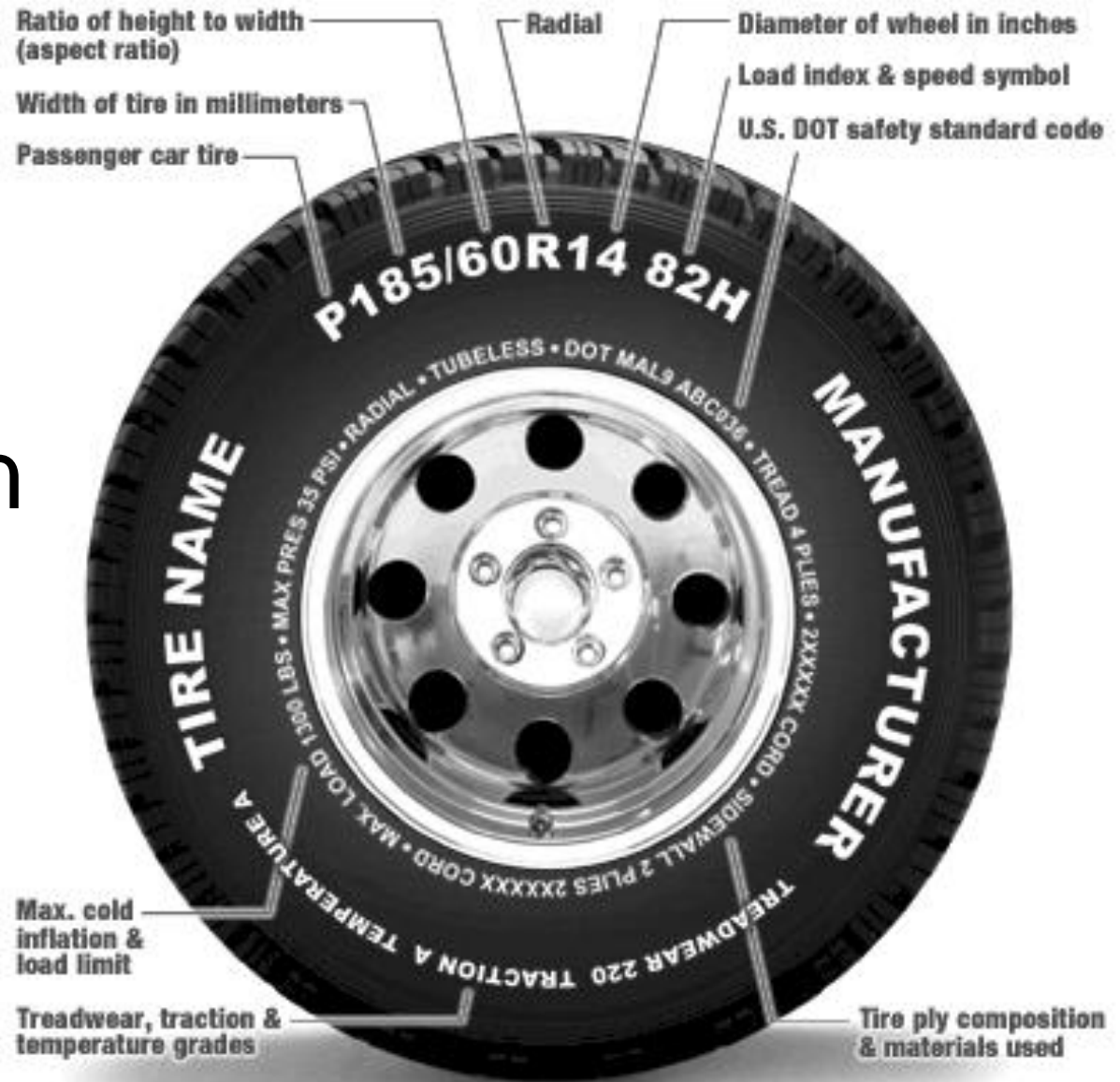
Which tire needs to be replaced? Can you tell?



Both tires need to be replaced.

Tire Markings and Information

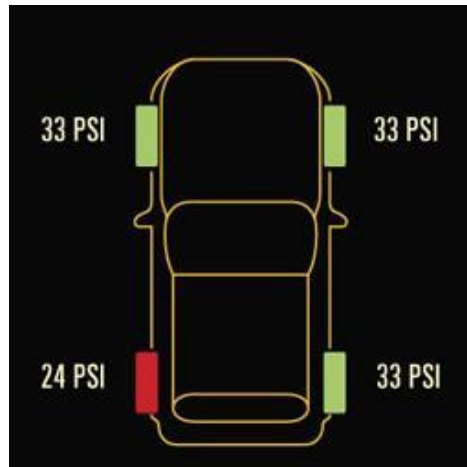
Routinely check your tire pressure!



WHAT'S YOUR PSI?



Tire at 32 psi
100% recommended pressure



Tire at 16 psi
50% recommended pressure

Student Activity 5a: Traction

Partners face each other, place your palms together and push against each other. One partner is the tire patch, the other is the roadway.

The one being the tire will move their hands about and the roadway follows. Have them move their hands slowly at first and see how the roadway responds. Then move their hands around quickly. What happens to the tire's ability to "hold the road"?

This demonstrates that traction is a function of friction and pressure.

Student Activity 5b: Loss of Traction

- Put your palms together and hold them together firmly.
- This time add hand lotion or baby oil or water.
- Rub them back and forth quickly for 30 seconds.

What happened this time as you rubbed your hands together?

Momentum in Winter



MAXIMUM VEHICLE LOAD

Vehicle Load Considerations

- Vehicle type and design
- Tires
- Suspension
- Height
- Width
- Number of passengers
- Amount of gear

Exceeding Maximum Load



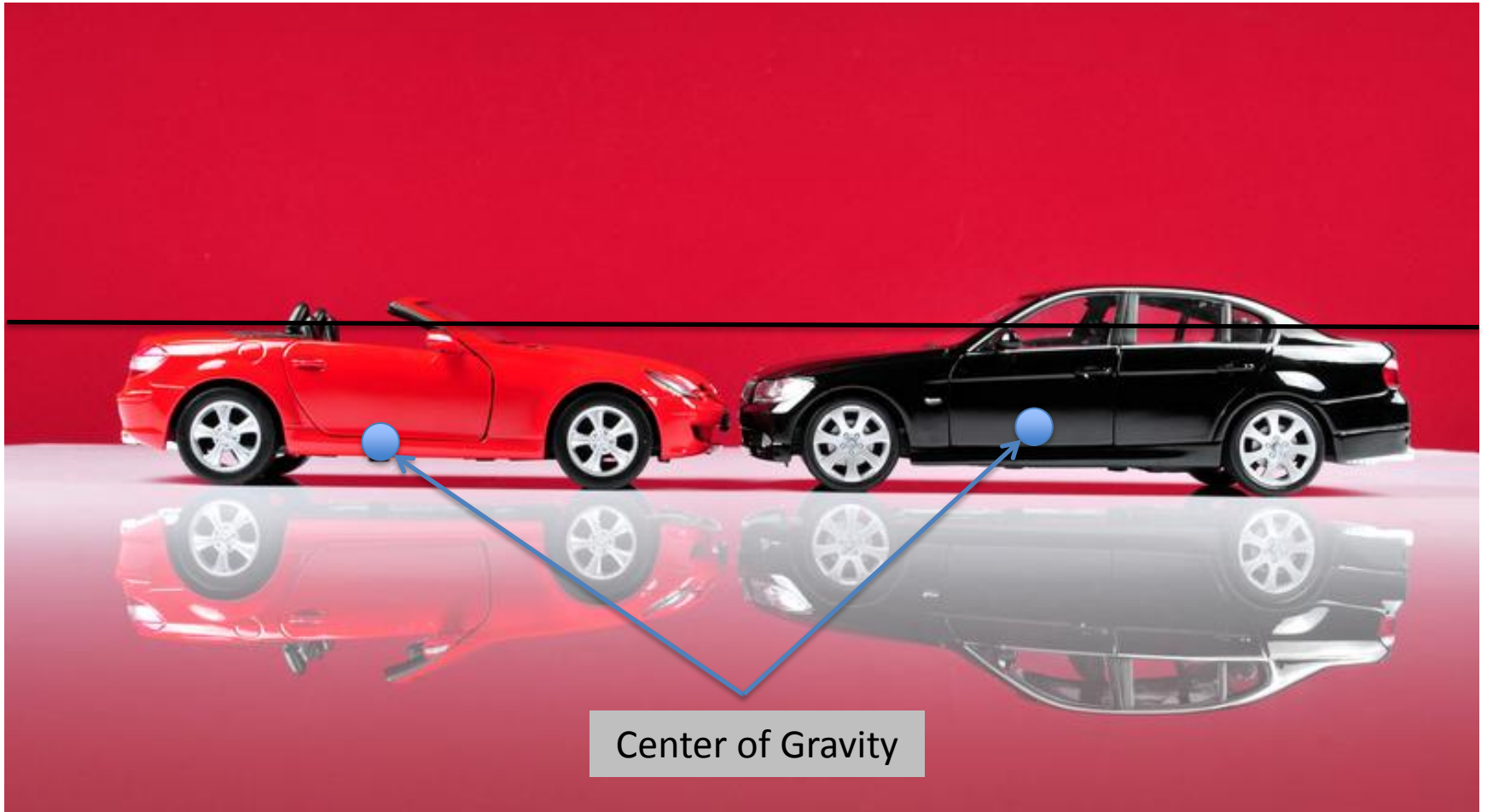




Load and Balance

“Center of Gravity”

Height of the Vehicle



Which one is more likely to roll over?





What about this vehicle's center of gravity?



What can I do to work within Natural Laws to manage risk and drive more safely?

PUTTING IT ALL TOGETHER

Manage Natural Laws by:

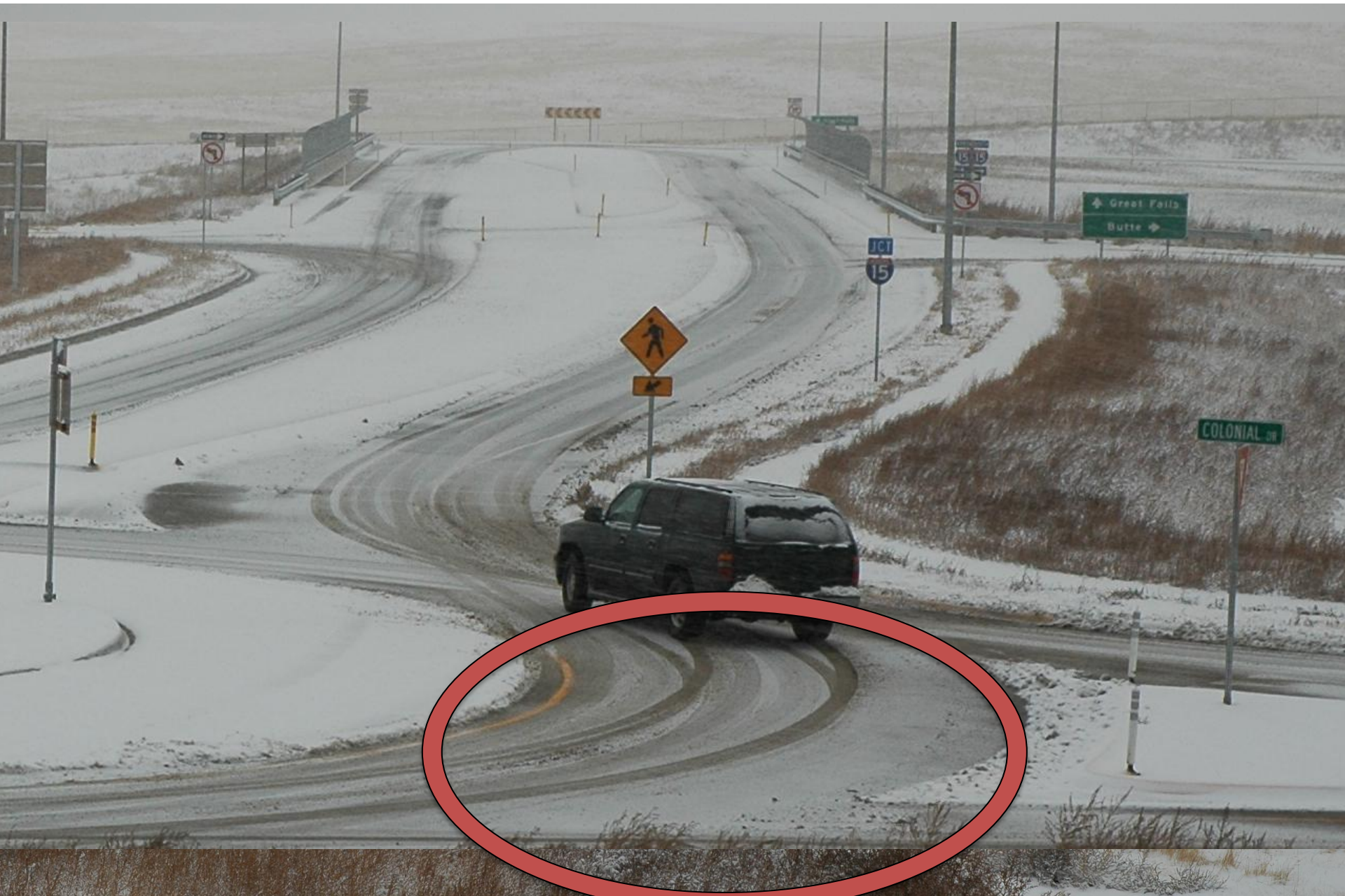
- Controlling vision
- Controlling motion
- Controlling steering
- Protecting occupants
- Maintaining your vehicle



Look at the following slides ...

- Using Vision Control, determine how you would manage the natural laws with
 - Speed (motion) control
 - Steering control





Vehicle Maintenance

- Tires
- Brakes
- Fluid levels
- Routine maintenance

Occupant Protection

- Vehicle Design and Natural Laws
- Safety Belts and Safety Seats
- Air Bags

The image shows a winding asphalt road in a rural, hilly landscape. On the right side of the road, a red car is overturned on its side on a grassy embankment. The road is bordered by a wooden fence and a concrete curb. The background features rolling green hills and some trees. The entire image is covered with extensive handwritten mathematical formulas and calculations in white and yellow ink, which appear to be a mix of physics and mathematics problems. The formulas include various equations involving variables like x , y , z , m , v , a , F , E , K , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k , l , m , n , o , p , q , r , s , t , u , v , w , x , y , z , a , b , c , d , e , f , g , h , i , j , k

Montana Driver Education and Training

Standards and Benchmarks

1. Laws and Highway System

- 1.1. know the laws outlined in the Montana Driver's manual;
- 1.2. understand the laws outlined in the Montana Driver's Manual; and
- 1.3. consistently demonstrate knowledge and understanding by responsible adherence to highway transportation system traffic laws and control devices.

2. Responsibility

- 2.1. recognize the importance of making safe and responsible decisions for owning and operating a motor vehicle;
- 2.2. demonstrate the ability to make appropriate decisions while operating a motor vehicle;
- 2.3. consistently display respect for other users of the highway transportation system; and
- 2.4. develop positive habits and attitudes for responsible driving.

3. Visual Skills

- 3.1. know proper visual skills for operating a motor vehicle;
- 3.2. communicate and explain proper visual skills for operating a motor vehicle;
- 3.3. demonstrate the use of proper visual skills for operating a motor vehicle; and
- 3.4. develop habits and attitudes with regard to proper visual skills.

4. Vehicle Control

- 4.1. demonstrate smooth, safe and efficient operation of a motor vehicle; and
- 4.2. develop positive habits and attitudes relative to safe, efficient and smooth vehicle operation.

(continued on next slide)

Montana Driver Education and Training

Standards and Benchmarks

5. Communication

- 5.1. consistently communicate driving intentions (i.e., use of lights, vehicle position, and personal signals);
- 5.2. adjust driver behavior based on observation of the highway transportation system and other roadway users;
- 5.3. adjust communication (i.e., use of lights, vehicle position, and personal signals) based on observation of the highway transportation system and other users; and
- 5.4. develop positive habits and attitudes for effective communication.

6. Risk Management

- 6.1. understand driver risk-management principles;
- 6.2. demonstrate driver risk-management strategies; and
- 6.3. develop positive habits and attitudes for effective driver risk-management.

7. Lifelong Learning

- 7.1. identify and use a range of learning strategies required to acquire or retain knowledge, positive driving habits, and driving skills for lifelong learning;
- 7.2. establish learning goals that are based on an understanding of one's own current and future learning needs; and
- 7.3. demonstrate knowledge and ability to make informed decisions required for positive driving habits, effective performance, and adaptation to change.

8. Driving Experience

- 8.1. acquire at least the minimum number of BTW hours over at least the minimum number of days, as required by law, with a Montana-approved driver education teacher; and
- 8.2. acquire additional behind-the-wheel driving experience with a parent or guardian's assistance in a variety of driving situations (i.e., night, adverse weather, gravel road, etc.).